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# 14 Recommendations for Future Research in Pesticide Risk Assessment for Pollinators



## CONTENTS



From the discussions in the preceding chapters, the following recommendations are proposed which aim at further improving the risk assessment scheme that could be developed in these proceedings.

## 14.1 EXPOSURE

### 14.1.1 Consumption of guttation water as a source of exposure

Various investigations of residues in guttation droplets collected from seed-treated crop plants revealed the potential for high residue levels to be present in guttation droplets (Girolami et al., 2009; Joachimsmeier et al., 2010; Schenke et al. 2010). Highest residues in guttation water occur immediately after seedling emergence and have been shown to decline with time. Current data suggests that monocotyledons tend to show guttation on a more frequent basis than dicotyledons. Some plants such as sugar beets produce practically negligible guttation. If bee hives are located in the immediate proximity to treated crops (field margin), some individual honey bees have been observed collecting guttation droplets (Girolami et al., 2009). If highly toxic systemic seed treatments or soil applications have been used, some individual forager bees could be potentially exposed to lethal levels of residues in guttation water. However, in currently available colony-level studies, neither

*Pesticide Risk Assessment for Pollinators*, First Edition. Edited by David Fischer and Thomas Moriarty.

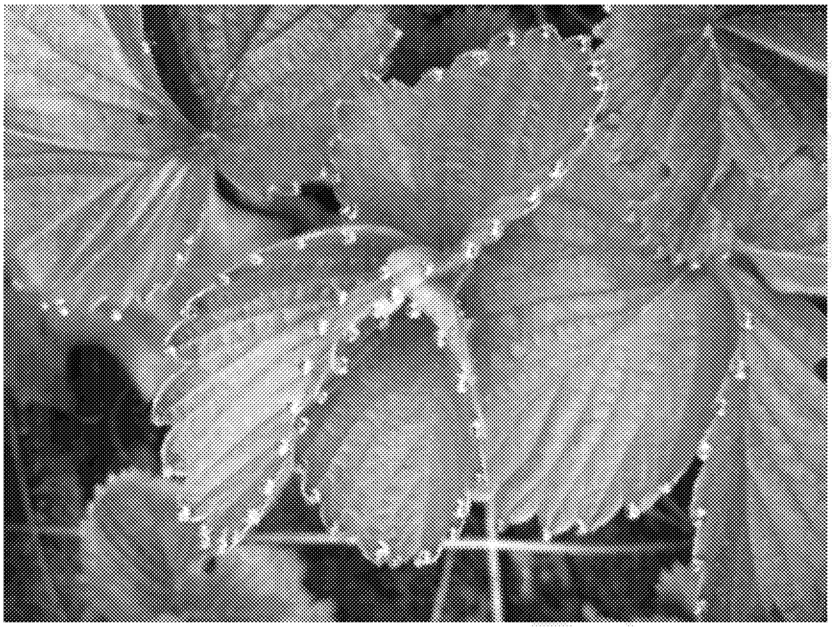

**FIGURE 14.1** Guttation water on a strawberry leaf, photo by Mace Vaughan (Xerces Society for Invertebrate Conservation). (For a color version, see the color plate section.)

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adverse effects on colonies, nor impact on beekeeping practices have been associated with pesticides in guttation water. Further studies are currently under evaluation, and more research is required to clarify if exposure of systemic pesticides through guttation water needs to be included in the pesticide risk assessment process.

### 14.1.2 Quantify in-hive exposure to larvae, queens, and other hive members for use in screening assessments

Data on actual exposure of larvae or other hive members could be established by chemical analysis of larval jelly, royal jelly, and beebread following a field application (such as in a semi-field or field scenario). Spraying a surrogate crop (e.g., *Phacelia* or buckwheat), enclosed in a tunnel containing a hive with minimal pollen and nectar stores would provide an optimal test system to measure in-hive exposure. Larval jelly and bee bread could be sampled from larval cells and analyzed for the appropriate pesticide residues. Data from a series of such tests that capture a range of mode of actions, application methods could be averaged to provide a generalized value to represent in-hive "pesticide" exposure (e.g., in larval food) for use in screening-level analyses. Analysis could include both foliarly applied and systemic compounds. For systemic compounds, representative crops could be selected and treated using different delivery routes. Residues in leaves, pollen, and nectar could be sampled over time, and particularly during flowering to determine uptake and decline rates of the pesticide. These data could help refine the default exposure calculation for systemic compounds and would also be helpful in determining the number of samples (e.g., beebread, larval jelly) that should be analyzed to obtain a robust and repeatable measurement of residue levels, and would also provide information to compare residue levels in pollen to that in other in-hive products, such as beebread.

## 14.2 EFFECTS

### 14.2.1 Role of inerts and co-formulants

Although pesticide effects testing typically focuses on the technical grade active ingredient in a relatively pure form (e.g., greater than 95% pure), these compounds are often applied as formulated products that contain other ingredients (e.g., adjuvants and/or surfactants). In certain cases potential effects from a formulated product may differ from the effects from the active ingredient *per se*. Also, the constituent elements of a formulated product have different chemical/physical properties that can cause the formulated product to behave differently in the environment than does the active ingredient, that is, a formulated product may dissipate at a different rate, consequently, methods for studying these products in an environmentally realistic way can be challenging. As there can be many formulated products associated with an active ingredient, methods are needed for determining which, if any, formulation should be tested in a manner similar to the active ingredient *per se*.

### 14.2.2 Comparisons between *Apis* and non-*Apis* species

An obvious knowledge gap identified by the participants of the Workshop is data to compare effects between *Apis* and non-*Apis* species. This includes effects in laboratory-based studies and semi-field and full-field studies (exploring both differences in sensitivity and susceptibility). One way to address this uncertainty is to include non-*Apis* bees in semi-field and field studies.

### 14.2.3 Reliable test for sublethal effects

There is a real need for reliable (field-level) tests for sublethal effects and a means to translate these effects into meaningful measures at the hive level, that is, to establish quantitative linkages between sublethal measurement endpoints on individual bees and more traditional colony-level assessment endpoints. Sublethal effects are most often made at the individual level but even when effects are noted it is difficult to extrapolate these effects to the whole colony. Research is needed to develop reliable test measurements to consistently document sublethal effects on bee behavior. Equally important is a means to translate these effects at the individual level to effects at the colony level. Suggestions for sublethal tests include a standard test for foraging disorientation that might include a "time back to the hive" or a maze at the hive entrance.

### 14.2.4 Determining the degree of adult or brood loss that affects colony productivity and survival

Losses of adult bees in dead bee traps and brood are often noted but the impact of these losses is hard to determine, especially if the losses are transitory. A series of experiments are needed to determine the rate of adult and brood loss necessary to impact colony productivity and pollination and ultimately colony survival. *Apis* colonies have a reserve of worker bees that serve to buffer the effects of temporary losses. However, there remains a fundamental uncertainty regarding the point at which the hive buffer becomes exhausted, and the colony is impaired.

### 14.2.5 Extrapolating from semi-field or field scale to protection goals

Currently, if any significant effects are observed or measured in semi-field or field studies, then it is predicted that protection goals will unlikely be met. This is due to the inability to confidently extrapolate from effects seen in a semi-field or field study to what may, or may not occur under field conditions. It would be extremely valuable if research could be carried out to link measurement endpoints, derived from a semi-field or field study, with protection goals. This may include not only well-designed testing, but well-designed post-monitoring as well.

There is a need for cost-effective reporting schemes that provide incentives to all parties involved, for example, beekeepers, applicators, and growers, to help increase accurate representation of use and effects of pesticide use in the field. This information would be an important input to the pesticide regulatory framework (i.e., risk assessment and risk management). Furthermore, a common platform for incident reporting between regulatory authorities would facilitate the sharing of incident data and management strategies.

Modeling has been identified as a promising tool for the purpose of risk assessment and risk management. Further research and work on model development for use in pesticide risk assessment for pollinators would help to document and refine modeled biological realism, sensitivity, robustness, parameterization, and calibration. Models could be used to explore potential linkages between measurement endpoints and assessment endpoints or protection goals. Models could also be used in support of extrapolation in time and space of the outcome of a risk assessment based on laboratory studies. Models could also be developed as a support in the design of higher-tier studies and landscape management. Collaboration between modelers and others such as regulators or entomologists would help direct model development and refinement.

The role that landscape management and alternative foraging and habitat resources may play in limiting the impact of pesticides and agronomic practices on pollinators calls for further research in this area. Typically monitoring studies undertaken in agronomic systems proposing diverse options for landscape management would provide feedback and support appropriate recommendations. Such approaches include population ecology, landscape ecology, and exposure characterization. It is noteworthy that the data generated may also feed model development and could thus be generated with the advice of modelers.

### 14.2.6 Efficacy of Mitigation Techniques

Research is needed to inform whether different risk mitigation techniques are efficacious in reducing the frequency or severity of bee poisoning incidents. For example, research could be carried out that investigates drift reduction technologies or the impact of vegetated buffers in mitigating spray drift or their effectiveness as a refuge and habitat for pollinators.

### 14.2.7 Data on Interactive Effects (For example, synergism)

More research is needed to inform the understanding of interactive effects between crop protection products, particularly between insecticides and fungicides. Evidence of interactions has been observed under laboratory conditions; however, the extent of these interactions in the field remains poorly described. Information on this, including research involving residues occurring in hives is needed to improve our understanding of whether label directions should be revised to restrict or prohibit tank-mixtures of certain pesticides/adjuvants/surfactants that are applied in conjunction with the pesticide and may be available as an exposure source to bees.

Of critical importance is information on the interaction between in-hive mite control chemicals (acaricides), applied by beekeepers for control of *Varroa* mites, and insecticides or fungicides applied to pollinated crops. Understanding linkages or relationships between these exposure mixtures and honey bee diseases is very important. Research in this area, in addition to that conducted by the US Department of Agriculture would improve the understanding of whether label use directions for in-hive acaricide applications and/or pesticide applications to flowering crops should be revised.

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**Author: Please provide the month and date of the meeting held in the reference "Schenke et al., 2010"**